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TOPICAL USES
OF
WATER IN SURGERY.

BY
CHARLES A. POPE, M.D.,
OF ST. LOUIS, MISSOURI.

PRESENTED TO THE AMERICAN MEDICAL ASSOCIATION,
AT ITS SESSION OF MAY, 1852.

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THE great importance of water is sufficiently evinced by the fact that the ancients ranked it among the four elements, of which they supposed all matter to consist. This arose less, perhaps, from its chemical composition, than from the extensive part it plays in the economy of nature. The three kingdoms, indeed, claim its presence in variable quantities; whilst it is absolutely essential to them all. Its action, being both chemical and mechanical, although gradual, is yet one of the most potent in the accomplishment of the changes which through long ages have been, and still are, in progress on the surface of the globe.

But of these, as well as its universal diffusion—its different states—its innumerable and varied uses—its importance to the organism and to life, and its application in medicine generally, it is not our purpose to speak. To treat even of all the questions more immediately connected with our subject would easily fill a volume, and tax beyond practical utility the patience of the Association.

We are to notice simply the local external effects of water in the department of surgery; nor even here will we more than allude to its being often required in the ordinary cleansing and dressing of wounds, ulcers, etc., and to its constituting a frequent, and sometimes essential menstruum for the application of many remèdes, whose beneficial effects are enhanced, if they do not even result as much from the water itself, as from the substances which it holds in solution. Instead of poultices and ointments, fomentations and lotions are greatly preferable, as they combine all the advantages without the ill effects of the former.

It is known that the use of water in surgery dates from the remotest antiquity; instinct alone would have dictated a resort to it, as the most natural agent for the mitigation of pain. Its history shows that scarcely any remedy has been the subject of greater reverses of

favour and neglect from its first to its latest employment. Amid such mutation of opinion, of exaggerated eulogy on the one hand, and unmerited obloquy on the other, it will be our endeavour to ascertain, if possible, its real value; to point out its therapeutic philosophy; and to indicate the classes of injury and disease in which it seems more especially applicable. Happy, indeed, should we succeed in any degree to elicit the attention of the members, and induce its more general employment by the profession of our country.

If we reflect for a moment on the vast influence for good or evil, of the local management of external lesions, as well as on their frequent daily and even hourly occurrence; how, on the one hand, those which are in themselves grave may, by care and skill, be conducted to a successful issue; and, on the other, those which are simple and apparently free from danger may, by ignorance or neglect, ultimately involve mutilation or death, the question, Which is the best mode of treatment? strikes us, at once, as one of momentous importance. We have not the vain hope that water, or any other single substance, will suit all the varying phases of such disasters, or prove a universal surgical panacea; still, should it be found, under philosophical guidance, to answer most, or even some of the indications presented in their management, the subject were well worthy of a candid investigation. That in numerous instances it is capable of answering even our highest anticipations, will, we hope, abundantly appear. Employed either warm or cold, in its solid, liquid, or vaporous state, simple or medicated, continuously or interruptedly, it were, perhaps, not difficult to show that water fulfils a majority, at least, of the indications presented in the topical treatment of external lesions.

In the remarks offered to the Association, it will be our chief object to direct attention to what we consider the most important points connected with the subject, viz: the *modus operandi* of water, when topically applied, and the therapeutical indications rationally based thereon. The history of its use in surgery, although of great interest, as well as the various modes of its application, must be very briefly noticed. Of these modes of local application we have affusion, fomentation, irrigation, lotion, immersion, injection, douche, etc. They may, perhaps, be reduced to three heads: water-dressing, irrigation, and immersion. The effects of water will vary according to its temperature, duration, and mode of contact, so that all these different methods are useful in their places. It belongs, therefore, to the tact and judgment of the surgeon to select that best adapted to the stage and circumstances of the case, and for the production of the desired

effect. For the details of the various modes of application, we beg to refer to the many memoirs on the subject, and especially to the thesis of Amussat the younger, whose excellent essay on the history and modes of application of water in surgery has, for the benefit of the American profession, been admirably translated by Prof. Frank H. Hamilton, of Buffalo. We also take pleasure in referring here to a small, though valuable work, entitled *Water versus Hydropathy*, or an Essay on Water and its True Relations to Medicine, by Henry Hartshorne, M. D., of Philadelphia. A short chapter is devoted to the uses of water in surgery, but the main object of the author was to "prove by instance and citation, for which no very laborious degree of research is necessary, how *largely* the profession have made use of that remedial element, the asserted *new* employment of which, in one mode only of its protean applications, is the boast and support of a set of medical pretenders."

On account of its simplicity and general accessibility, water must undoubtedly have been employed from the earliest ages of the world in the treatment of external lesions. Instances of its use occur both in Homer and in the Bible; but it was reserved for Hippocrates to methodize its application. This great man seems to have fully comprehended its action and value. Indeed, but little has been really added to our knowledge on the subject since his time; points which he broached having simply been developed, and the modes of applying water been regulated and extended. In his book, *De Humidis*, are found numerous ideas which have been generally supposed to belong to more modern times. Celsus and Galen also employed water in many surgical affections; but the simplicity and good sense of such an example were soon forgotten amid the polypharmacy and pompous vulnerary display of their less skilful followers. For many centuries these continued in vogue, and, in accordance with the superstitious spirit of later times, disputes arose as to which was the better vulnerary, simple or blessed water; every surgeon supposing that he possessed the true panacea. Among the miracles wrought by more vaunted and complex remedies, simple water met with but little notice; for, although employed, it was mixed with various ingredients, and accompanied with some absurd form of incantation, to which all its good effects were ascribed. In the sixteenth century, the great Paré, his pot of boiling oil having run out, learned by accident the surgical value of water: nor did he hesitate to acknowledge its successful employment by a noted empiric. He imitated the practice of Maitre Doublet, but saw, however, that its

virtues were not attributable to “mysterious words and unchristian ceremonies, but to the simple clear water.” Such was the spirit of the age, and the force of example, that he had long refused, on account of religious scruples, and its supposed supernatural effects, to employ water in the dressing of wounds. Even after Paré, the same strife as to the relative merits of simple and blessed water continued, until it was fortunately and forever settled by the chancellor of the University of Montpellier.

Towards the beginning of the eighteenth century, Lamorier endeavoured to extend the employment of water, contending that there were few wounds which could not be healed by this treatment, more promptly and satisfactorily than by any other means. But it is to Lombard, a French military surgeon, that the modern revival of the practice is especially due. He established more precise rules for the use of water than any of his predecessors, in a work published in 1786, at the instance of Baron Percy. In an admirable article on this subject by the latter, in the *Dictionnaire des Sciences Médicales*, is to be found much historical and useful information, so largely drawn upon by succeeding copyists. Such were the convictions of Percy of the utility of water, that he declares, if deprived of its use, he would relinquish military surgery.

It were an interesting task, did it comport with the objects of a Report, to notice the labours of those who, at different epochs, and often amid contumely and ridicule, have contributed to rescue water from neglect, and to extend its use in surgery. We must, however, content ourselves with the names of those already mentioned, and enumerate such only of the moderns as have been foremost in their advocacy of water dressings. Of the dead were Danter of Berlin, Kern of Vienna, Baron Larrey, who used the waters of the Nile, Breschet, Liston, Dieffenbach, M'Cartney, Walther, Josse, and Bérrard. Among the living, are Cloquet, Jæger, Chelius, Guthrie, Græfe, Miller, Langenbeck, Stromeyer, and, perhaps the most enthusiastic admirer of the practice, M. Baudens, the distinguished French military surgeon at the Val de Grâce. He employs ice to a great extent, and contends for its superiority as a topical application.

Notwithstanding the vaunted and even acknowledged beneficial effects of water, and its frequent employment, as we have seen, by the ancients, in almost all external affections, its use even now is far from being general. In the hospitals of Germany, it is perhaps more extensively used than in those of France or Great Britain. In the hospitals of this country, also, with a few exceptions, the old methods

of poultices, ointments, and dry dressings (lint compresses and bandages), still find wider favour than the more simple and cleanly water applications. In private practice, both on this and the older Continent, the advocates of the latter are perhaps more numerous, and water-dressings are in more frequent requisition.

The mode of action of water is an important inquiry. But this will vary according as it is applied, cold, or warm, or hot, interruptedly or continuously, to the whole or a part of the body. No generalities on its *modus operandi* can, therefore, well be given, so that we shall proceed to consider its effects according to its temperature, duration, and mode of contact. It will also be more clear and satisfactory to indicate, under each head, the diseases and conditions in which its use is deemed advisable.

I. *Cold Water from 35° to 55° Fahr.*—Its effects will differ according as applied in an interrupted or in a continued manner.

If its application be occasional or interrupted (intermittent irrigation of Bérard), there is an immediate diminution of the temperature of the part, and a contraction of its capillaries, with a retardation of their circulation. The skin shrinks, becomes pale and cool, whilst the cutaneous secretion is impaired, or altogether suspended. There is also a diminution in the size of the part, the blood being repelled to the more internal organs. It is upon this principle that frequently heart disease occurs in a too long continued use of the cold bath. These phenomena continue whilst the application lasts, and gradually extend to the subjacent structures. If the contact be but slightly prolonged, reaction ensues. The blood driven with force by the deeper vessels, again dilates the capillaries, which yield “like a spring that has been bent.” They are even increased in caliber, and are traversed in a given time by a greater number of blood-globules. Redness of the skin, with elevation of its temperature, and an increased size of the part, and sometimes augmented secretion, result from the more rapid circulation. A familiar example of this reaction is afforded by washing one’s hands in winter with snow. Sometimes the reaction is excessive, reaching the true inflammatory state, with its highest result, mortification, as we see in cases of frost-bite.

When thus used, water is therefore an indirect excitant of no inconsiderable power, and we perceive at once the therapeutical advantage which may be derived from it, in imparting tone to

weakened parts, and stimulating actions useful to the exercise of important functions.

It follows, therefore, that the interrupted application (occasional showerings or immersion) of cold water will be useful.

1. In frost-bite of the first degree. In these cases, frequent frictions with cold water, snow, or ice, are highly successful, as attested by the observation and experience of all ages. The circulation is thereby gradually restored to its proper equilibrium, and undue or too rapid reaction (inflammation with probable loss of substance) is effectually prevented.

2. As a hemostatic. In minor hemorrhages, arterial, venous, or capillary, cold water, applied with a sponge, or poured on the part, constricts the vessels and thus affords a mechanical obstruction to the bleeding orifices. In hemorrhages not admitting the ligature, as the parenchymatous, the styptic effects of cold water are very successful. Attempts have even been made to substitute it for the ligature after amputation, but improperly, for besides there being no valid objection to the use of the ligature, the patient may be exhausted by its uncertainty, and too much time be lost, thus delaying the purpose of the operation. In epistaxis, as well as in bleeding from the fauces, rectum, and uterus, cold water is used with the happiest results.

3. In certain chronic and indolent ulcers, as those occurring on the lower limbs, the stimulating effect of cold water may be taken advantage of to excite healthy granulations, and predispose to form cicatrization.

4. As a means of strengthening the organic fibre, giving tone to enfeebled parts, and rendering them less amenable to catarrhal, rheumatic, scrofulous, and other inflammatory affections. Thus the diurnal washing or showering of particular parts of the body is often an excellent prophylactic. A daily cold pediluvium is known to diminish the liability to contract catarrh. According to Percy, the cold douche may prevent or even cure spontaneous luxations, and remove incomplete (extra-capsular) ankylosis. Hippocrates long ago advised them in non-ulcerated scrofulous joints, and in the topi of gout and rheumatism; and advantage is said also to have been derived from their use in cases of deformed callus, rickets, etc.

Continuous Application of Cold Water.—When cold water is applied continuously to a part, the reaction which follows its temporary contact will also take place; its effects, however, being suspended or prevented by the continued renewal of cold. The

temperature of the part remains diminished, the transient reactive pain passes off, the redness and tumefaction of the skin disappear. The vitality of the part is depressed, and its irritability is moderated.

If the contact be maintained for a long time, the blood, which is constantly driven from the contracted and diminished capillaries, is compelled to take another direction. This tendency may be increased, both by diminishing the mass of blood, and by counter-irritation at a distant point. Thus we may moderate or prevent an inflammation, or sometimes cause it to abort when already established. In other cases, we can drive the blood from an engorged organ, or inversely to a point where its presence is desirable.

As the continuous application of cold deprives a part of its caloric, it acts like an antiseptic, in preventing chemical decomposition and putrefaction, which cannot occur without a certain degree of caloric.

From what we have said of the *modus operandi* of cold water continuously applied, it should prove especially salutary in the treatment of the inflammatory process. And since inflammation in its various stages is itself the great and frequent condition or complication, which the surgeon is called upon to combat, and it is in its treatment that the benefits of refrigerants have been most lauded, whilst the opposers have here raised their most serious objections, we shall be excused on account of its importance for dwelling somewhat on this head.

The means employed for mitigating or abolishing inflammation have been classed by McCartney, in his admirable work on the subject, under seven heads:—

1. Remedies which diminish the force of the heart, and give the disposition, generally, to the small arteries, to go into the contracted state.

Along with nauseants and general and local abstraction of blood, refrigerants certainly diminish the size of the small vessels, and consequently the force of the heart also, so far at least as this is concerned in impelling the blood through the constricted capillaries of a part. Cold water unquestionably fulfils this indication.

2. Means that effect a diminished size of the arteries, or reduce the sensibility in the inflamed part.

Cold applications do both; and the more superficial the vessels the greater the effects, as in violent sprains of joints.

3. Lotions or fluids which exert sedative and astringent power.

Here, too, cold water, even by itself, and unmedicated, completely answers the purpose.

The remaining four heads will find their appropriate place hereafter, when we come to speak of water of a higher temperature than we are now considering, and we shall show how, by lowering or increasing its caloric, a most important element in the management of external lesions, it perfectly answers all the requisitions for the treatment of inflammation, so clearly laid down by the above-cited author.

It is in traumatic inflammation, of the true sthenic type, accompanied by much pain, redness, heat, and swelling, such as occur in wounds, contusions, fractures, etc., that cold water is especially serviceable. But from the view which we take of its therapeutical action, it follows that the water should be applied cold as long only as there is hope that the inflammation will terminate by resolution. If it tend by its nature to suppuration, or if suppuration be already established (and this may sometimes be desirable), cold applications are no longer proper, for they would retard unavoidable suppuration. Here the water should be brought to the proper relaxing temperature.

We are of opinion that the effects of refrigerants do not extend very deeply, and that, therefore, the inflammation should not be very profoundly situated to be favourably modified by their use. Seated, for example, towards the axis of the thigh or trunk, less advantage would be gained from their employment than when its site is in more superficial parts. Indeed, some care is requisite in these cases, as the cold may mask the inflammatory symptoms and suppuration, which it may be important early to detect.

Different opinions have been entertained concerning the mode of the therapeutical action of cold water in inflammations. Thus, the mere reduction of caloric, the effect on the nervous extremities, the absorption of the water, the diminution of the quantum of blood in the part, the uniformity of its temperature maintaining a new action, the development of electrical phenomena, have each found supporters. Without denying the participation of any, we incline to think that the diminution of the quantity of blood, and the abstraction of caloric, act the most prominent and important part. These at least are sensible and appreciable effects, and we should adopt them in preference to mere speculation and hypothesis. Absorption, it is true, does go on during the continuous application of cold, as is easily proved by the experiment of Percy, who plunged a new-born puppy into a black-coloured liquid, the urine being thereby rendered black. So also turpentine, when applied externally, imparts to the

urinary secretion its peculiar odour; and morphine, as well as tartar emetic, applied in solution to the surface, will produce on a patient their characteristic effects of stupor and nausea.

Cold applied to an inflamed part is, in one sense, a kind of bandage. But over the bandage, cold possesses this advantage, that while it compresses (constricts) it also largely depletes the part by its abstraction of caloric. The two, by means of a wetted roller, are often advantageously combined.

Certain experiments, made several years ago by my colleague, Prof. M. L. Linton, satisfactorily show that, when a bandage is applied to several or all of the extremities at the same time, the pulse becomes *fuller and slower*. He has hence deduced some most useful and important practical hints. In exhausting and threatening discharges of the secretions or of blood, the vital fluid may be as it were dammed up, in order to sustain the functions of the "tripod of life," the heart, the brain, and the lungs. It is well known that the amputation of a leg causes plethora, and many other facts find their explanation by this view. Although of far less avail in these particular cases, yet similar effects are produced by cold water when applied to one or more of the extremities.

We have selected a number of healthy individuals, whose pulse was accurately noted both before and during immersion in water at different low and ascertained temperatures, and have found the results to accord quite accurately with those obtained by Dr. Linton with the bandage. On the other hand, by applying ligatures to the limbs, so as to detain the blood from the trunk, the pulse became feebler and quicker. The student upon whom he made some of his experiments said that the bandages caused a feeling of fulness about the head; apart from which he observed no other notable change in his sensations. A somewhat analogous fact has been communicated to me by a reliable medical friend. A man engaged in removing the wreck of a sunken steamboat remained for a considerable time with his body immersed up to the chin in the cold water of the Mississippi River: for some days afterwards, he was the subject of raving mania, and continued for some time to evince symptoms of cerebral congestion; for the treatment of which affection he had fallen under the care of my friend, who, by applying cold to the head, and warm water to the extremities, succeeded in completely relieving him.

If, according to the doctrine of Bérard and Barthes, we admit that inflammation consists of several elements, and we attack one of these before inflammation is established, we may succeed in preventing its

development. When inflammation already exists, our success in its treatment will depend on the relative value of the one or more elements which we aim to subdue. Thus opium in large doses, by calming pain, often prevents the phlogosis: thus leeches act by drawing off the redundant blood. So, too, cold applications, in whatever manner continuously used, combat the burning heat and afflux of blood, both before and after their appearance. In certain instances cold increases the pain, and warm water is required. But this appears evidently to be the case when the injury is deep-seated—the cold being superficial in its effects, increases the congestion towards the axis of the part, whereas warm applications, by attracting the blood towards the surface, relieve the central congestion.

In inflammations which are regarded as specific, such as syphilis, erysipelas, scrofula, and rheumatism, cold applications should be used with greater caution. Our predecessors, however, often employed cold effusions both in smallpox and scarlatina, as well as in other eruptive fevers, and we see at the present day, the hydiatic treatment often successful in rheumatism. The reason of an objection to cold in these cases is the belief in the existence of a *materies morbi*, which must be eliminated, and which, if repelled from one part, is driven to another. In primary syphilis after destruction of the virus, water-dressing is highly appropriate and beneficial. In erysipelas, we fear the repelling effect of cold, which often produces a metastasis to the brain or elsewhere.

It is important here to observe that age, sex, sensibility, the nature, seat, extent, and severity of the disease, the season as well as the period of its first application, are all so many circumstances to be regarded by the surgeon in his selection of the manner, quantity, duration, and temperature of the water to be employed.

We may proceed to indicate the cases in which the continuous use of cold water is advantageous: 1. As a local anæsthetic. From the effects which we have described as following the application of water of a low temperature, we should, *à priori*, infer its use in obtunding sensibility. We produce a frost-bite of the first degree, when the part is said to be “dead.” Benefit in this way can only be obtained in parts of no great thickness, as the phalanges of the fingers and toes, amputations of which have been thus performed, without the patient experiencing the least pain. General anæsthesia by the usual means of ether or chloroform inhalation will for such purposes, on account of a more rapid indication of the desired effect, be perhaps preferred: still, cases contraindicating the exhibition of these very

exceptionally dangerous agents may occur, when for the removal of fingers or toes or the ablation of certain tumours, as we have ourselves practised, it may be desirable to resort to other means, or to the local anæsthetic power of cold. Here, as in other instances, to prevent undue reaction, the cold applications of a gradually more elevated temperature should be continued as the after treatment. Do not ether and chloroform produce local anæsthesia by their evaporations inducing cold? Certain it is, we think, that their major action may in this way be explained, as their local and general effects seem so widely to differ.

2. In inflammation of particular parts, as (a), in inflammation of the brain, especially when induced traumatically. Notwithstanding the fear once felt in the use of cold applications to the head, they are now, next to bloodletting, generally acknowledged to be one of the most powerful remedies in the treatment of such affections.

(b.) In ophthalmia, attended with ocular pain and cephalic congestion. Some of the German surgeons are fond of cold applications in all purulent ophthalmia, as they think that they prevent the discharge, and mitigate the violence of the disease. Here, too, its place is next to bloodletting. In the *ophthalmia neonatorum*, cold water has been found very serviceable, and excellent success has also attended its employment in serofulous photophobia.

In simple catarrhal ophthalmia, cold applications should not be too long continued. Their good effects are most marked in the earlier stages, when, failing, their continuance is likely to induce a rheumatic complication. Poppy and other anodyne fomentations are then preferable.

(c.) In traumatic inflammation of the thoracic and abdominal cavities, as contusions, wounds, etc., attended by extravasation of blood. Many surgeons who employ cold applications in affections of the limbs fear their use about the trunk, on account of the proximity of serous surfaces, which they allege take on consequent inflammation. Marshall Hall strongly recommends them even in ordinary hemothysis, and they have been and are still used in metro-peritonitis with decided advantage.* Our own experience is decidedly favourable to them in bleeding, and penetrating wounds of both cavities of the trunk, and we have not noticed the production of this dreaded pleurisy

* But in these cases there is danger, for, as it is difficult for the cold to act except at the periphery, it may cause deep-seated congestion. Hence, if water be applied at all, it should be in an uninterrupted manner, and at a very low temperature, so as to diminish the circulation of both the superficial and central vessels.

or peritonitis to be attributable to their action. Is there not also a serous membrane of the brain? but we are not on this account deterred from their use in traumatic lesions of the head. The osseous envelop is not a sufficient explanation of the difference in the two cases.

(*d.*) In orchitis, cold applications act most beneficially, so long as the true sthenic character prevails. According to Rusk, their use should not be too long continued in the inflammation of glandular organs, because of the indurations which are likely to follow. This surgeon is very partial to the use of cold water in almost all external diseases, but for the reason assigned does not admit its employment in orchitis even of a traumatic origin. He prefers in such cases warm sugar of lead fomentations. This induration, with enlargement, almost always follows inflammation of the testicle as an immediate consequence, under every treatment, and I am not aware that it more frequently follows the use of refrigerants than other remedies. In the earlier active stages of orchitis, their use will, as in other inflammations, be found, on trial, consonant to the general rule.

In inflammatory enlargements of the superficial lymphatic glands of the groin, along with rest and a compressive bandage, we have found cold applications very useful in effecting a return to their normal size. There are buboes which will suppurate in spite of all and every treatment. In such, the specific for example, where suppuration is by many regarded as an elimination of the poison, we withhold the use of refrigerants.

(*e.*) In inflammation of mucous surfaces, as gonorrhœa, leucorrhœa, chronic cystitis, etc., the applications of cold water, either by fomentations, irrigation, or injection (in case of the bladder, by means of a double catheter), are very useful. The cold imparts tone and strength to the relaxed and weakened membrane. In the case of the penis, local cold baths are generally to be preferred to injections. Uterine injections, however, have of late years met with favourable reception in practice.

(*f.*) In paraphymosis, the use of cold water is highly serviceable. It diminishes inflammation and engorgement, whilst it favours the spontaneous reduction of the glans, or proves an efficient aid to the manipulatory efforts of the surgeon. The water should be poured upon the part from a height for twenty minutes or half an hour before attempting the restoration. We have never yet seen a case at all acute which has resisted this means and required a resort to the knife.

Cold applications are applied not only to cure inflammation already

established, but far oftener to prevent its accession, when likely to follow previous injuries. With this view are they especially used

1. In wounds. The more important the organ injured, the more we should strive to ward off inflammation, and consequently the more urgently are cold applications indicated. In wounds of the head, of the external soft parts, as well as of the cranium and brain, in wounds of the chest and abdomen, either penetrating or not, and, lastly, in wounds of the extremities, cold water is a chief remedy, and should never, unless for major reasons, be neglected. Its beneficial effects are most marked in incised wounds, as amputations and the like, where we wish union by the first intention. This important and generally desirable process is not in the least hindered, but on the contrary is often promoted by the judicious use of refrigerants. In lesions implicating joints (especially the knee) and peri-tendinous sheaths, no other application is superior, although we should not neglect venesection, and other means of cure. Did it comport with the plan of the present paper, we might cite many striking cases in illustration of the great benefit of cold applications.

In contused, lacerated, and gunshot wounds, they are no less serviceable. Here it is true that a certain amount of inflammation must follow, nor is it intended, as some suppose, altogether to prevent its occurrence. We aim simply to moderate and restrain, not to prevent or absolutely control. In the first period of gunshot wounds—that of shock—cold applications ought, for obvious reasons, to be withheld. As this state passes off, they should, however, be sedulously made. While, on the one hand, there is but little doubt that in many a grave gunshot, or other injury, were the treatment by continuous irrigation or immersion in cold water, amputation might often be prevented, and thus both life and limb saved; on the other, in those comminuted fractures, with division of large bloodvessels and nerves, and other serious disorder, we should not indulge the vain hope of saving by water or any other treatment, that which it would be both safer and more useful to remove.

As to the length of time required for applying cold water, it will depend evidently on the circumstances of the case; a few days being sometimes sufficient, while in others a month or more is necessary. Instances are given in which the applications have been continued for three months. It is important to remember that, when from any cause it may be deemed advisable to discontinue the application, it should not be done suddenly, but gradually, and by the substitution of water of a more and more elevated temperature. By this means

the rapid and undue reaction will be prevented, and a more formidable inflammation averted.

With respect to the danger of mortification from the continuous application of cold, it is by no means clear that the contusion itself was not the chief cause of the mortification in cases where this has occurred. Certain it is that snow and ice would more likely predispose to this untoward accident, which the judicious surgeon can generally foresee and prevent. Bérard has twice seen, under these circumstances, the mortification of the great toe. Whenever the connections of the contused part are such as seriously to interfere with its circulation, gangrene is to be apprehended, and cold applications are to be most warily used. So, too, in severe fractures, accompanied by paralysis; the vitality of the part being lowered, the danger of mortification by continuous cold is enhanced.

Another objection to continued irrigation has been made by M. Piorry. It is, he says, a kind of injection, which dissolves the pus, introduces it into the open vessels, and thus causes *pyæmia*. The removal by such means of the pus and septic detritus of a part was, it would seem, a means rather of preventing than of inducing systemic infection. Besides, under the use of cold water, the quantity of the discharge is diminished, and there is consequently less danger of absorption.

2. In concussion, particularly of important organs, as the brain, lungs, and abdominal viscera. Here of themselves cold applications are often sufficient to prevent the development of inflammation. It is important to recall the fact that, in all cases of severe shock, the system should be permitted to recover either naturally or by restoratives, before resort to irrigation or immersion.

3. In bruise, or contusions of soft as well as of hard parts; in fractures, luxations, and sprains, cold applications are used according to the same rules. In sprains, momentary luxations self-reduced, conjoined with rest and position, no remedy is equal to them. In the swelling and pain which so soon follow on fractures and dislocations, cold water, by abating both symptoms, is an admirable aid in enabling us to examine satisfactorily in order to an exact diagnosis. It is equally serviceable in their after treatment. Dupuytren supposed that cold, whether by water or the atmosphere, retarded and occasionally prevented the formation of callus. This can be true only when the fractured bone is near the surface, and when the cold is applied to such a degree as to diminish that vascularity of the part necessary to the formation of callus.

4. In incarcerated and strangulated hernia, cold water not only prevents the expected inflammation, but also greatly assists the taxis by its contractile effects. It is when the protruded bowel is greatly distended by flatus that its beneficial influence is most marked. Freezing of the parts in such cases is said to have occasionally occurred, an event which moderate attention might easily forestall.

In prolapsus of the rectum and of the vagina, as also in hemorrhoids, cold water often proves salutary in facilitating the reduction of the displaced parts, on the one hand, while, on the other, it prevents the inflammation which might follow.

5. For the cure of aneurism and varices. Combined with compressive bandages, cold water has been used with success, especially if the case be recent. It has generally been restricted, except as an adjuvant to compression, to internal aneurisms, as of the aorta, etc.; the external being amenable to more certain means of cure. The examples of success, according to the method of Valsalva and Albertini, are in part to be attributed to the continued application of cold. Ice has cured aneurisms; but the best mode of applying cold is to envelop the whole limb, including the aneurism, with a roller, which should be kept constantly wet with water at a low temperature. In cases of internal aneurism, where a cure is not effected, the cold serves at least to delay the fatal termination.

6. In all degrees of burn, cold applications, although objected to by many surgeons, have enjoyed great reputation from the most ancient to the present time. Pain is at once relieved. The application should, however, be continued, as a suspension would be followed by increased inflammation and pain, more agonizing than if cold had never been used. In very extensive burns, however, cold water is of doubtful utility, on account of its sedative effects on the already depressed system.

7. In commencing bed-sores, cold applications are usually very serviceable.

After the operation for cataract, the constant application of compresses saturated with cold water has a marked effect in preventing the development of inflammation.

II. *Ice Water of 32°*.—This, as well as snow, and ice, and water, of the same temperature, produces an action similar to that already noticed, with the difference that its effects are more powerful; and it is therefore especially applicable in cases requiring a very active treatment. It is important to observe that there is a great

difference between the effects of water at 32° and those of ice or snow at the same temperature, from the fact that either of the latter, in passing to the liquid state, renders latent a quantity of caloric equal to that which is required to raise the temperature of an equal weight of water from 32° to 172° . Gangrene is much oftener the result of the inconsiderate employment of ice or snow, than of water, how cold soever it may be. There is only the exception of frost-bite, in which frictions of snow should precede the use of water of a gradually increased temperature, through fear of gangrene.

M. Baudens, as before observed, is the great partisan of the use of ice in surgery. It is, he says, theoretically speaking, difficult to understand how a limb may be encased in ice for eight, fifteen days, and even a month, without danger, when one may so easily convince himself that, by holding a piece of ice between the fingers for a minute only, it suffices, so to speak, to freeze them, and cause severe pain, with insupportable constriction. In this case, the ice acts on healthy tissues, whilst it should be employed only on tissues traumatically injured. In one case, the ice subtracts the normal caloric; in the other, it withdraws that which is pathological. The distinction is important, and should never be lost sight of. This great abstraction of pathological caloric is what M. Baudens aptly calls a local bleeding, not of blood but of caloric. In his essay on this subject, read before the National Academy of Medicine, he says that it is incredible, to those who have not witnessed the fact, that the patient who has been relieved by this powerful discharge of morbid caloric, which would quickly freeze a limb in its normal conditions, declares the limb to be still hotter than the other. By the touch, it is easy to convince one's self that the patient is right: that, if the external tegumentary layer be cold, there exists deeply an intense focus of pathological heat. From the principles laid down, this is all clear enough, and is by no means strange. But it may be asked by what means did M. Baudens assure himself of it by the touch. We can conceive of his touch recognizing the superficial coldness; but it is more difficult to understand how it could at the same time recognize the deep-seated heat.

Ice, ice-water, snow, and all frigorific mixtures, may be used in traumatic inflammation of the head and joints, in violent contusions of these parts, in severe ophthalmia, and in a number of other cases whose indications admit of their use. Ice is best applied by being folded in a towel, put into a bladder, or, if to the spine, in the large intestine of an animal.

In certain idiosyncrasies, the use of ice is contraindicated, from its producing an erysipelatous inflammation. This may be owing partly to a tender skin, and partly to the existence of inveterate rheumatism. With Velpeau and Guthrie, we are of opinion that ice cannot, for obvious reasons, become of general use in hospital or military practice; but we should not on this account forego its employment when indicated, and easily accessible.

Recently, M. Fleury has instituted some skilful experiments with cold douches in the treatment of various diseases, particularly chronic diseases of joints, chronic engorgement of the uterus, and tumours of different kinds, with the view of causing their reduction and absorption. Of the value of cold water in the two first-named affections we have already spoken: it is on the last that we would make a few remarks. The advantageous results obtained by M. Fleury establish beyond a doubt that cold douches constitute, by the excitation which they produce in the tissues upon which they act, one of the most powerful resolute agents with which we are acquainted. Dr. Sloan has tried cold douches in three cases, one of cystic tumour, one of goitre, and one of scirrhus breast, and with such success that they should suffice to fix the attention of the profession upon this new resource of our art. Each douche made daily, occupied from one to five minutes. The treatment in the cystic tumour was continued for three months, at the end of which time the tumour had diminished one-fourth its size. The goitre lost five-sixths of its volume, and the scirrhus breast became stationary, the skin resuming its normal appearance.

We can scarcely hope that cold douches or anything else will supersede the general treatment of tumours by extirpation; but in those capable of absorption, as the sarcomatous and tubercular, the douches may be attended with excellent results. If in the malignant and the non-absorbable growths, as well as in those cases where an operation may be deemed unwarrantable, they delay increase of bulk, a good is surely obtained. We hope this subject will receive the attention it merits, and that facts sufficiently numerous to establish some general conclusions will be speedily collected.

III. *Tepid Water*, 75° to 95° Fahr.—It is of this temperature that water is most commonly used for the purpose of cleansing wounds and ulcers, and for softening adherent dressings hardened by the secretions of the part. In wounds and ulcers occurring in irritable constitutions, the local lesions partaking of the same character, and

in persons and seasons contraindicating the use of cold, the tepid water dressing is both comfortable and beneficial. Where ulcers present a thin, ichorous discharge, tepid water improves the secretion, producing laudable pus and healthy granulations, and thus favours the desired cicatrization. Kern, of Vienna, is extravagant in his praises of tepid water, as a general dressing in all wounds and ulcers of either a simple or specific character. In ulcers of the skin, and particularly those indolent ones with indurated margins which occur on the lower extremities, he thinks it superior to every other treatment. Its too long-continued use, however, in ulcers, rather delays than favours the healing process, which often requires a treatment precisely contrary in its effects to those produced by tepid water. Tepid water is generally and preferably employed also by M. Amussat, as set forth in the thesis of his son before alluded to. He thinks it possessed of all the advantages, while it is at the same time free from the objections urged against cold water, and should therefore be generally preferred. The rule which many ancient, as well as modern surgeons, follow in the use of water is to have it of a temperature agreeable to the sensations of the patient; and in many cases it may yet be considered as the best guide.

IV. *Warm Water, 95° to 125° Fahr.*—Warm water produces immediately the same effects which we pointed out as characterizing the reaction that follows on the cold applications when made for a short time. By its influence the capillaries dilate, give an easier passage to the blood-globules, and admit them in a greater number at once. A flow of blood indeed is established whose energy is in proportion to the temperature of the water, and the duration of its contact. When not exceeding 125°, there is merely an acceleration in the circulatory movement; but beyond, and especially if the application be prolonged, we may have all the degrees of burn, from simple rubefaction to the most complete mortification. We take advantage of this property of warm water to diminish dangerous congestions, by drawing off the blood to other points, where its accumulation is of no inconvenience. As cold water serves in part the purpose of a bandage, so does warm water that of a monster cup. This is but the counterpart of the ligature to the limbs and confirmatory of those suggestions of Dr. Linton above referred to—which we have verified by experiment. Thus, in cerebral and other dangerous internal congestions, we bathe the feet in warm water, to divert blood from the tender brain or other important organs. By the afflux of blood

which its application produces, we use it after leech-bites to encourage bleeding.

Warm water is essentially relaxing; it penetrates the tissues, distends and softens them, favors circulation, without rendering it much more active, and is well adapted to all cases where we seek to subdue irritation, rigidity, and dryness. Ordinarily it is customary to incorporate it with some soft substances in the form of poultices, the good effects of which, it is contended, are owing solely to the warm water (heat and moisture) which they contain. The chief objection to warm fomentations is the rapidity with which they cool, thus subjecting the part to great alternations of temperature. This may be guarded against, in a great measure, by a covering of oiled silk; thus preventing evaporation, after the manner of Liston's poultices, which are preferable to farinaceous or other substances.

Immersion, if the part admit of it, is the best mode of application, and a great desideratum is to find out a method by which this may be effected, and the limb be at the same time maintained in an elevated position.

In inflammation which must terminate in suppuration, warm water, however applied, is very successful. It matures abscesses, and by its relaxing effects diminishes the pain and tension attendant on tightly confined pus, as when situated in dense cellular and fibrous tissues, or beneath fasciæ and the periosteum. Next to the relieving incision, warm water is in such cases the best and most agreeable remedy.

By some, it is supposed that the power of warm water in causing the abortion of inflammation is very considerable; still, relief certainly follows much more rapidly the use of cold.

Although the general effects of warm water be relaxing, it is true that at the moment of contact the vessels diminish in caliber by tonic contraction, particularly if the liquid be near ebullition. The sudden immersion of the finger in hot water, it is said, is thus an excellent means of arresting, in its *début*, the development of a whitlow: the tonicity of the capillaries is called into play as just stated, and their sudden contraction expels the blood which obstructs them.

The vapor of hot water is of very useful application in a variety of cases. The advantage of making a continued, instead of a temporary application, and dispensing at the same time with the woollen cloths used in common fomentations, which irritate many wounds and ulcers, gives to the mode of administering steam, as recommended by McCartney, the character of a *new remedy*. The temperature, which is so essential an element in all local remedies, can be varied at will,

from a degree of heat too great to be borne, down to below the standard temperature of the human body. It is probable, indeed, that the soothing influence of a common fomentation is owing to the steam generated, yet it is not denied that their agreeable effects may be increased by the addition of aromatic plants. The effects of steam, says McCartney, at a high but comfortable temperature, are gently stimulant, and at the same time extremely soothing to the feelings of the patient. When the remedy is used, as recommended, by his apparatus, immediately after the receipt of any of the following accidents, viz., lacerated gunshot and punctured wounds, contusions of bones, fractures near joints, recent luxations, bruises and sprains of joints, and in all wounds accompanied by a peculiar overcoming pain, and a shock to the nervous system, it removes all pain and consciousness of injury in a very short time. After the pain and the sense of injury have passed away, the steam at a low temperature may be continued; or, if found more convenient, water-dressing may be substituted. In injuries to joints and bones, the temperature of the steam ought to be gradually reduced; and when there are open joints, compound luxation, or compound fracture, we may meet the invasion of inflammation (if it should occur) by bleeding, leeches, and cold, according to circumstances. At a low temperature, steam reduces the heat and vascular dilatation, while it soothes the sensations of inflamed parts. Tepid steam is useful in healing ulcers, and those with luxuriant granulations, but hot steam is preferable in the indolent class of sores. Steam is also singularly beneficial in inflammation of a more active character, attended by violent pain and tension, as in phlegmonous abscess, promoting very rapidly the thinning process by which the tension of the cavity is removed, and the pus brought towards the skin. In certain muscular contractions, in rheumatic ophthalmia, in abscesses of the mouth or ear, in suppressed hemorrhoidal or catamenial flows, in non-malignant indurations of the mamma, and in the suppression of milk, steam is highly serviceable. Such, at least, are the views of McCartney.

It has been contended that, as simple penetrating wounds of the great cavities of the body are not dangerous so much in themselves, as by the admission of air to surfaces unaccustomed to its presence, it were possible, by excluding this agent, to perform many otherwise grave operations implicating joints and serous cavities with comparatively little danger. Thus the extraction of loose cartilages in joints, and the removal of ovarian and other abdominal tumours, might be more safely attempted in an atmosphere of steam, of a temperature

the same as that of the body. Were the operations performed under water at the proper temperature, it is likely that the same wished-for results would follow. But these procedures are attended with such difficulties and inconvenience, as the coloration of the water, &c., that they are never likely to be frequently, if at all, resorted to.

V. *Boiling Water, 212° Fahr.*—When water of this elevated temperature is brought in contact with the skin, it produces in a lower degree an erysipelatous, and in a higher a true phlegmonous inflammation, followed by suppuration; or, by diminishing the vitality, it may so far injure the structure of the part as to cause its immediate death. It belongs, therefore, to the class of rubefacients, though irritating the skin more powerfully and being consequently a greater derivative. In apoplexy, apparent death, or where instant vesication is required, hot water, applied either with compresses or a sponge, is preferable to the ordinary rubefacients. According to Rust, hot water is a very excellent remedy in fistulous ulcers, in order to produce an active inflammation in their walls, which may lead to their agglutination and closure. It thus acts in the same way as caustics or the actual cautery, whether heated by fire previous to its introduction, or subsequently, as platinum wire by galvanism, as lately proposed. He also uses it in abscesses of the lymphatic glands with the same view. His method is to open the abscess at its most depending part by a lancet or trocar, evacuate its contents, and inject as much hot water as is sufficient to fill the cavity, allowing it to remain for a few seconds. Caustic potash or iodine injections are perhaps preferable in both cases.

In morbus coxarius and other destructive affections of joints, hot water is far inferior to either issue, seton, or moxa, for it is likely to produce ulcerative inflammation, followed by atonic ulcers, which usually heal with great difficulty.

We are now prepared to notice the remaining remedies for inflammation, and to show how well, by varying its temperature, water fulfils every local indication.

1. Medicines (remedies) that augment or reproduce the natural secretions, and thereby abate the circulation, or lessen the effusions made into inflamed parts.

We have just seen how warm water answers these intentions.

2. Counter-irritations, secretions, or impressions, made in different parts from those inflamed.

Here the vesicant effect of hot water is available.

3. Means for modifying, in an agreeable manner, the sensations of inflamed parts.

Steam of a comfortable temperature, or even cold water, fully and admirably answers this indication.

4. Causes which produce an easy or satisfied state of feeling, on the sentient surfaces, or in the individual.

Whatever gives ease to an aching part will also tranquillize the individual, so that this indication also is met by the application of either steam or cold water. Moreover, under the two last heads, the application of anodynes, when deemed advisable, is best made when dissolved in an aqueous solution, whether warm or cold.

In conclusion, we would express the conviction that the Association has acted wisely in substituting essays on special subjects for the multiform reports of former years; for the mind, concentrated on a particular topic, is apt the better to perceive all its relations and bearings.

Whether we have succeeded or not in shedding any additional light on the theme assigned us, we at least feel confident that, in its investigation, we ourselves have derived both pleasure and advantage.

